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ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST

Committee for Coordination of Investigations
of the Lower Mekong Basin
(Cambodia, Laos, Thailand and Viêt-Nam)

STUDY OF THE ENERGY MARKET FOR HOUSEHOLD, COMMERCIAL AND INDUSTRIAL USES IN THE LOWER MEKONG BASIN

Quarterly Progress Report No.6

by

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French Government/SOFRELEC Domestic Power
Market Survey

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I - INTRODUCTION

The study of the energy market for household, industrial and commercial uses in the four countries constituting the Committee for Coordination of Investigations of the Lower Mekong Basin was covered by the Plan of Operation published as document E/CN/H/WRD/MKG/L 69 Rev.2 of 31/10/62.

Operations began on March 1st, 1963. They have been described for the period between 1st March 1963 and 31st May 1964 in quarterly reports No.1,2,2,4 & 5.

This report covers our activities for the period from 1st June 1964 to 31st August 1964.

II - GENERAL DESCRIPTION OF THE WORK ACCOMPLISHED

The activities of the Mission included:

- completing the processing of the data from the detailed electricity consumption surveys;
- drafting of Points 2, 3 & 4 of reports concerning each country.

A special effort has been made in connexion with the reports on Cambodia and Thailand.

The description of work done in connexion with Cambodia, Laos, Thailand and Viêt-Nam is given below.

/ CAMBODIA

CAMBODIA

The final drafting of Points 1, 2 & 3 was completed during the quarterly period under review.

Some complementary information have been collected in the field of electricity data. This enabled us to partly fill the gaps that remained in the material pertaining to the consumption of self-producers and licensees. Thus, the study of consumption previsions (point 3) could be completed. We have now turned to the processing of data concerning the development programmes (point 4) and pilot districts (point 5). In addition, complementary data are sought to better assess the different economic alternatives in the field of equipment, as well as the respective benefits and drawbacks of the various possible solutions.

LAOS

The study of the data collected enabled us to develop a fairly representative statement of the present pattern, both in the economy and the electricity fields.

The drafting of the report is to begin very soon. It may however be feared that, at least in the economic field, the report be much less detailed than the others, owing to gaps resulting from the lack of accuracy of statistical data. However, the electrical data on the recent years, which are fairly complete, make it possible to evolve a more detailed study of Points 2 & 3.

/ THAILAND

THAILAND

The data on consumptions have been completed. They were sufficiently abundant to make a study on consumption previsions possible. According to the method outlined in Report No.5, previsions could be formulated in finalized form.

Activities, during the quarterly period under review, were accordingly devoted to the preparation of the final report. Points 1, 2 have thus been finalized, while preparation of Point 3 has been practically completed. Elements have been gathered for the study of Points 4 & 5 (programmes of equipment and pilot districts). Despite difficulties arising from the existence of numerous producing and distributing entities, normal headway could be made with data gathering. However, a number of crucial decisions have to be made shortly about the specifications of the networks to be installed (e.g. voltage of primary distribution) and it would be desirable to know the answers before the winding up of the Mission. Also, the progress of the equipment programmes now being implemented must be carefully followed with a view to working out the elements which must serve as a basis for the study of development programmes.

During the next quarterly period, activities will be devoted to the completion of the preparation of Point 3 (consumption previsions) as well as to the preparation and drafting of Points 4 & 5.

/ VIET-NAM

VIET-NAM

The collection of data relating to the economic situation has been pursued and completed. Then, these elements have been analyzed.

1 - Population

The data relating to population outside Saigon-Cholon being non-existent, we had to resort to estimations in connexion with the present and past population figures. This is essential for the preparation of previsions on electricity consumption for household uses.

2 - National product and national income

A survey of the Banque Nationale du Viêt-Nam on the national product has been completed. It related to the evaluation of the net domestic product at factor cost in 1960, 1961 & 1962. This means that we are in possession of estimates of the net domestic product, in the absence of estimates of the gross domestic product.

Serious difficulties were encountered in the assessment of added values for each branch. This work, however, is necessary to assessing the growth of the different branches, and, next, their energy consumptions in the past and in the future.

3 - Electricity

Three sampling surveys, previously made on the elctricity consumptions in Saigon-Cholon, covered the years 1954, 1962 & 1963. A last sampling survey had to be made for the year 1958 in order to determine the trend of consumptions during the period 1953 - 1960. The processing of the results of this last sampling will enable us to achieve the study of electricity consumption previsions.

/ During

During the quarterly period under review, the drafting of Point 1 (overall economic situation) was completed, except for the components relating to the evolution of economic aggregates (gross domestic product). The components relating to Point 2 (present & past situation of electricity production and consumption) have been collected and the drafting of this section is nearly completed.

During the next quarterly period, the study of Points 1 & 2 will be finally completed and the drafting of Point 3 will be undertaken, as the components have now been gathered. Also, data relating to the networks and equipment projects will be sought with a view to starting the study of Point 4 (development programmes) and 5 (pilot districts).

III - ESTIMATED PROGRESS OF THE SURVEY

CAMBODIA

The progress percentage is about 80%

LAOS

The progress percentage is about 40%

THAILAND

The progress percentage is about 75%

VIET-NAM

The progress percentage is about 65%

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ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST.

Committee for Coordination of Investigations
of the Lower Mekong Basin.
(Cambodia, Laos, Thailand and the Republic of Viet-Nam)

CAMBODIA, LAOS, THAILAND AND VIETNAM

Survey of Four Tributaries

United Nations Special Fund: Mekong Committee/Survey of Four Tributaries

Report by the United Nations
Department of Economic and Social Affairs
For the Period 1 January – 30 September 1964

SUMMARY

Tributary Projects

i) The Project Report for the Phum Leao damsite on the Battambang Tributary in Cambodia has been completed by SOGREAH. The report is now being reviewed by Cambodia, the Project Engineer and ECAFE.

ii) The Nam Ngum Tributary Project had been revised by Nippon Koei in the light of the suggestions made by the Advisory Board in its meeting held at Phnom Penh in November 1963. The Advisory Board visited the Nam Ngum damsite on 2 May 1964 and was most favourably impressed with the excellence of the site for a concrete dam. The Board concluded that the first stage of the Nam Ngum Tributary Project (20,000 KW power and 5,000 irrigation) is fully justified technically, economically and financially, and recommended early construction of the Project.

iii) Good progress was made on the construction of the Nam Ngum Tributary Project in Thailand. The foundation stone for the dam was laid by the Prime Minister of Thailand on Sunday 10 May 1964.

iv) Nippon Koei submitted an interim note on the progress of the Upper Se San Project in Vietnam for review by the Advisory Board in April 1964. The ultimate hydro-electric potential of the Upper Se San has been shown to be of the order of 600,000 KW, of which Yali Falls itself could generate 180,000 KW. The Engineer hopes to complete the Feasibility Report by the end of August 1964.

Agricultural Stations

v) The request for Kalasin Station in Thailand sponsored by the joint effort of the Thai Ministry of Agriculture, the Ministry of National Development, the FAO Regional Office, and the Office of the Committee's Executive Agent, has been approved by the Governing Council of the Special Fund. It is hoped that the draft may be available for negotiation sometime in late July or early August 1964.

/ vi)

vi) Cambodia has made a separate request for financing the construction and operation of an Agricultural Station in the Battambang area in Cambodia. This request is still under consideration of the Special Fund.

vii) The Special Fund has agreed to the extension of the agricultural pilot and experimental station in Laos by one year.

viii) At the end of January 1964, a formal request was submitted to the United Nations Special Fund for changing the location of the experimental and demonstration farm from the Upper Se San to the Eak-Mat Agricultural Station situated in the Upper Sre Pok Basin in Viet-Nam. The Special Fund agreed to shift the pilot project to Eak-Mat. Contour mapping at Eak-Mat Farm has been finished and planning of irrigation system has been taken in hand.

ix) Taking the Project as the whole, the progress up-to-date is considered very satisfactory indeed. It is hoped to bring the Project to a successful completion during 1964.

STATEMENT OF WORK DONE

i) Battambang Tributary Project in Cambodia

SOGREAH submitted the Feasibility Report for Battambang (Phum Leao site) during June 1964. Five copies in French were received in Bangkok on 17 June 1964; two of these copies were sent to Cambodia for scrutiny. Two copies in English are expected during July. The remaining 95 copies in French and 98 copies in English were dispatched by sea. These have since been received. Out of these, 24 copies in French have been sent to Cambodia and two copies to each of the other 3 countries.

/ The report

The report is still under detailed scrutiny by Cambodia, ECAFE, and the Project Engineer. Their comments will be sent when their scrutiny has been completed. The SOGREAH report is an excellent presentation of the project and undoubtedly is of a high professional standard.

The development project provides for the reclamation and drainage of about 80,000 hectares adjoining the chief town in the Province of Battambang. Four fifths of the area (that is, 68,000 hectares) is proposed to be brought under irrigation; the difference of 12,000 hectares is accounted for by unproductive soil, "phnoms" roads, villages and land covered by the various irrigation and drainage network structures. The irrigation water supplied will be diverted from the Stung Sangker by the Kantu dam after storage at the Phum Leao dam.

Extensive geological survey and investigations were carried out to dispel any doubts as to the water tightness of the reservoir basin before the Phum Leao damsite was finally selected. SOGREAH has recommended a two-stage building programme to be in keeping with the progressive development of the project.

The first stage contemplates building the dam upto a level of 70 metres. This will provide electric production for a peak output of 5,000 KW.

In the second and the final stage, the dam would be built up to 80 metres and the mean power available would amount to 19,000 KW. The Project recommends a stand-by steam power station with an installed capacity of 20,000 KW.

The total cost of the Project has been worked out as US$50.87 million, plus 1,420 million Riels. The cost of the first stage comprising the Kantu dam and the left bank area canal has been estimated as US$10 million and 364 million Riels.

/The report

The report ends by strongly recommending the development project as a worthwhile basis for the expansion of the agricultural and power resources of one of the most prominent provinces in Cambodia.

ii) Nam Ngum Tributary Project in Laos

Nippon Koei Ltd., designing and consulting engineers of Tokyo, submitted the Feasibility Report on the Multi-Purpose Nam Ngum Project in Laos during April for the consideration of the Advisory Board. This report included all the suggestions made by the Advisory Board of the Mekong Committee, the Project Engineer and others at various times.

The Nam Ngum Multi-Purpose Project envisages hydro-electric power generation, irrigation, flood control and navigation improvement by the construction of a 66 metres high concrete gravity dam. Power generation in the first stage would be limited to 20,000 KW and will ultimately be increased to 120,000 KW. Similarly irrigation in the first stage will be limited to 5,000 hectares and will be expanded to 32,000 hectares in course of time.

The cost of construction of the first stage of the Project is estimated as US$22.4 million, of which US$15.2 will be in foreign exchange and the remaining US$7.2 million in local currency. About US$2 million may be required to meet the interest charges during the construction period.

At its meeting held in early May 1964, the Advisory Board of the Mekong Committee reviewed in detail the estimates of cost. While the Board was of the opinion that these estimates appeared reasonable, it felt that the item for reserves and contingency might justifiably be increased.

/ The Board

The Board took into account the impact on the rest of the economy of this major effort in economic development, the possibilities for a rapid increase in the demand for power, following the availability of abundant power at reasonable cost, the stabilization influences of expanded opportunities for employment, the psychological advantages in bringing together various parties within the country, all of which are dedicated to the Project, and the opportunity this Project provides for co-operation with neighbouring countries within the Mekong Basin, including the possible export of power to Thailand. Taking all these considerations collectively into account and considering the feasibility of the Project itself over years, the Board recommended early construction of the Project as a contribution to the economy and stability of the country concerned as well as of the region.

Nippon Koei will now proceed with the final printing of the Feasibility Report. The United Nations agreed (Mr. Elms' letter of 24 April 1964, Amendment No.5) to extension of the termination date of the contract to 31 August 1964 as requested by the firm. The only work which remained to be done was the printing of the final Feasibility Report, 100 copies in English and the same number in French. These copies have since been received. Out of these, 24 copies in French have been sent to Laos and 2 copies to each of the other three countries.

iii) Nam Pong Tributary Project in Thailand

The Nam Pong Tributary Project in Thailand has made excellent progress under the Thailand North-East Electricity Authority (NEEA), which has been specially constituted for the construction of the Project.

The foundation stone was laid by H.E. Marshal Thanom Kittikachorn, the Prime Minister of Thailand, on 10 May 1964. The contract for the construction of civil engineering work was awarded to the Philipp Holzmann AG and the Siemens Bauunion for Baht 162 million on 23 January 1964.

/The Prime Minister

The Prime Minister, on this occasion, stated: "Nam Pong Dam is "part of the development of the Mekong River, which is under the auspices of "the United Nations. The United Nations initiated the survey and prepared "various feasibility reports with the help of many countries all over the world. "When the Project proved to be feasible, it was handed to the Thai Government "to carry on."

On this occasion, the Secretary General of the United Nations sent the following cable to H.E. the Prime Minister Thanom Kittikachorn and to the Chairman of the Mekong Committee, Dr. Boonrod Binson:

"On occasion of placing foundation stone for Pong Neeb Dam "on Sunday 10 May as first component project to reach physical "construction stage within overall Mekong scheme, I have great "pleasure on behalf of UNATIONS Family including ECAFE and "UNATIONS SPECFUND to convey warmest felicitations to your "Government. We in UNATIONS take modest pride in support we "have extended to Mekong Committee as an autonomous intergovernmental "organization under aegis of UNATIONS and in providing through "UNATIONS SPECFUND finance for Feasibility Report as first step "in preparation present Nam Pong/Pong Neeb Project. UNATIONS "reiterates its warm support of Mekong Committee as vehicle "through which riparian states Cambodia, Laos, Thailand and "Republic Viet-Nam seek major economic development for all peoples "of Lower Mekong Basin without distinction as to nationality or "politics. We greatly hope construction at Nam Pong which now "well underway will prove of great benefit for people of North-East "Thailand and equally will service as an encouraging example to "all riparian partners within Mekong Committee. Please accept, "Your Excellencies, the renewed assurances of our highest "considerations. Signed: U Thant."

/iv)

iv) Upper Se San Tributary Project in Vietnam

Nippon Koei continued investigations. The Project planning, design and evaluation were carried on at the Head Office of the firm. They expect that the Feasibility Report on the Upper Se San Project will now be completed by August 1964. This extension in the period of the contract to 31 August 1964 without in itself having any effect on the total contract price was agreed to by United Nations with Mr. Elms' Amendment No.1 of 4 March 1964. Nippon Koei submitted a note for discussion at the meeting of the Advisory Board held in April 1964. The firm reported that their subsequent investigations show that the Project area including the newly added South-West area of Pleiku has a very complicated topography, making it difficult to develop a large irrigation system. Nippon Koei have come to the conclusion that it would be advantageous to consider several small sectors of about 1,000 to 5,000 hectares by lift irrigation, obtaining cheap power from the proposed Yali Falls development.

As regards hydro-electric part, the Upper Se San has an ultimate potential of some 600,000 KW; Yali Falls itself could generate 180,000 KW. However, in the light of the present demand in this region, it is considered appropriate to develop the project by stages. The firm is proposing for the first stage development about 8,000 hectares for irrigation and 5,000 KW for power at a cost of something like US$10 million. Out of 8,000 hectares of proposed irrigation, 5,000 hectares would possibly be by gravity and 3,000 by pumping.

The field work was completed in August. Nippon Koei on 10 September 1964 handed over to the Government of Viet-Nam two cars with their accessories to be in their custody on behalf of the Mekong Committee.

A graph is enclosed showing the progress of expenditure from the inception of the project to the end of August 1964. A separate chart shows the percentage of work done under each head.

/ The firm

The firm hopes to submit 24 copies in English and the same number in French within 30 days after completion of the job in August, i.e. during the period of September 1964.

ANALYSES OF MAJOR PROBLEMS ENCOUNTERED

Survey of Four Tributaries

i) Five copies in French version of the Feasibility Report for Battambang project (Phum Leao Site) was received from SOGREAH during June 1964. Two copies in English specially requested by air are expected shortly. Remaining copies have been dispatched by sea. The report is now being examined by Cambodia, ECAFE and the Project Engineers. A claim of SOGREAH for US$13,800 for additional mapping is under consideration of the United Nations.

ii) A few advanced copies of the Feasibility Report for Nam Ngum Project in Laos were received from Nippon Koei Co. of Tokyo during April 1964 for review by the Advisory Board. The Advisory Board has enthusiastically recommended the construction of the first phase of the Project and it is hoped that the required funds for starting construction will be found under some financial arrangement. The firm hopes to send 100 copies in English and the same number in French of the final printed reports by August 1964. The firm's claim for US$2,500 for printing the additional copies is still under consideration of the United Nations.

iii) The work on Upper Se San in Vietnam was continued by the firm. The completion of the Feasibility Report will be delayed until end of August 1964. This delay will not involve the United Nations in any additional financial obligations.

/ GOVERNMENT

GOVERNMENT PARTICIPATION

i) Each of the participating Government assigned a Counterpart Manager to the respective Tributary Project. The Counterpart Manager had worked closely with the Project Manager of the contractors and the Project Engineer of the United Nations Special Fund, responsible for the work.

Counterpart personnel and facilities were provided by Governments to the contractors, as stipulated in their contracts. Contractors were generally satisfied with the contribution in kind made by the Governments.

EVALUATION - AS AT THE END OF REPORTING PERIOD

i) The position of the Project at the end of the period may be considered as very satisfactory. The Four Tributaries Survey Project was supposed to fade out on 29 February, and from 1 March, costs were to be transferred to the new Institutional Support Project, the savings being applied to the anticipated extension of the Laos Agricultural Station Project (Mr. Reedman's letter of 5 May 1964). This can be formally done, when the Plan of Operation for the Institutional Support Project has been signed by the parties concerned.

ii) The Nam Pong Project in Thailand is making very good progress. The foundation stone was laid by the Prime Minister of Thailand on 10 May 1964.

iii) The revised Feasibility Report on the Nam Ngum Project, Laos, was reviewed by the Laotian Authorities, the Advisory Board, ECAFE and the Chairman of the Mekong Committee; all of them have enthusiastically supported the construction of the first phase of the Project. The contract for this work will terminate on 31 August 1964 on receipt of the final printing copies of the Feasibility Report from the firm. In the meantime, the Mekong Committee,

/ with the

with the good offices of the United Nations, is exploring ways and means for financing the construction of this important project in the Mekong Basin.

iv) The Feasibility Report on the Battambang Project in Cambodia was received in June 1964 and is being scrutinized at present. With the completion of the scrutiny, the contract for this Project with SOGREAH will come to a successful termination. The Advisory Board has already supported the First Phase of this Project for construction.

v) The Upper Se San Tributary Project has been unavoidably delayed. The field work had been completed at the end of August 1964 and printed reports delivered in September 1964. The ultimate potential of the Project is much bigger than visualized previously. It has been learnt during recent discussions that the emphasis of Vietnam Government has now shifted to Upper Sre Pok Tributary area.

Agricultural Station

1. Cambodia - Pilot Station for Irrigated Agriculture, Battambang

On 21 January 1964, at a meeting held in Phnom Penh, the Government confirmed their interest in the project for establishing a pilot station for irrigated agriculture in the vicinity of Battambang.

The Managing Director of the United Nations Special Fund, recommended a Special Fund Project for a Pilot Station for a duration of 4 years at an estimated Special Fund contribution of US$551,300 and a Government counterpart contribution equivalent to US$500,000.

This project is to provide demonstration and training in methods of irrigated agriculture in the area to be developed by irrigation with water from the Battambang River. It consists of the study of the most effective utilization of the water to become available, first from the diversion dam and then from the major works proposed on the Battambang river, testing of modern methods of irrigated agriculture suitable for the area, research and demonstration on the diversification and rotation of crops and training of local personnel in the management of irrigation and in agricultural extension.

A fifteen hectare pilot station is planned bo be located about 7 km from the town of Battambang and will be surrounded by a demonstration perimeter of 300 ha.

2. Thailand - Experimental and Demonstration Farm for irrigated Agriculture, Kalasin

According to the meetings of the Consultative Board of February 1964 and of the Governing Council of 20 April 1964, a draft Plan of Operation was prepared and discussed and the final copies sent to the Special Fund and to the FAO Country Representative in Bangkok for negotiation and signatures on 30 October 1964.

/ The project

The project is of 4 year's duration and the Special Fund Allocation to this Project is estimated as US$321,100 a.d the Government Counterpart contributions is equivalent to US$277,904. This Project is to study how the water made available under the irrigation scheme can be best utilized, to test modern methods of agriculture, to conduct research and provide demonstrations on irrigated crop production and on the optimum diversification of cropping, to advice the Government on legislation and rules for water use and to train local personnel in all these fields.

The project will provide for the establishment of a 10 hectares irrigation farm and a demonstation area of 300 hectares, both of which will be provided with irrigation facilities from the existing Huey Si Thon tank nearby.

3. Vietnam - Eak-Mat Experimental and Demonstration Farm in Vietnam.

A formal request to the Special Fund for changing the location of the experimental and demonstration farm from the Upper Se-san to the Eak-Mat agricultural experimental station was sent by the United Nations TAB Regional Representative in the Far East on 23 January 1964.

After approval by the Special Fund, a new memorandum agreement between FAO and the Government was signed in April, which provides for a total allocation of US$38,000 for a preparatory survey of the physical conditions

/ of the area.

of the area. The topographical survey has been made by a private firm. The Cadastral and soil maps, the engineering design and the socio-economic study are being carried out by the Government technicians and FAO local personnel.

/ Laos

4.	Laos Vientiane Agricultural Station Operations authorized to commence on 16 January 1961	1 January through 30 September 1964 FAO

A. Summary of Project Operations

The experimental work previously developed to obtain pointers was intensified. Particular attention was given to recording and analysing data on consumption of irrigation water.

Irrigation network has been completed in the first zone of the pilot area and a start has been made on the construction of the canals in the second zone.

Demonstration and extension activities have been intensified and are alredy showing practical results. All data on results, experimental and crop and extension activities up to May 1964 were submitted as preliminary reports.

The Agricultural school has completed the first year of its two years course. The programs of study have been modified to suit local needs.

An extension of one year has been granted to this project.

B. Work done during Period under Review

(a) Experimental Station

During the period of report, experiments on 40 species and 118 varieties of crops were carried out and distributed over 178 plots. The water requirements of the various crops were controlled.

/ The results

The results obtained from cereals other than rice continued to maintain their promise. The yield from wheat was almost double that of last year, while maize, sorghum and durra yields continued to be of economic interest in view of the increased demands. Economic benefits of a second crop of rice still remains doubtful.

Experiments on cash crops confirmed previous year's results. However, most of these crops are not economical in the present situation as there are no marketing facilities. Tobacco is an exception, both the local and imported varieties yielded good results and were economical under irrigation.

Vegetables are much more economical as the produce is readily sold at a good price. Various legumes were tried as green manure. The yields were high and on the basis of the experiments relative rotations have been determined. It is possible to obtain two crops during the dry season.

Druing the rainy season, experiments were focussed on rice. Artificial seed drying was tried. Experiments on crops grown in the previous year were continued and measures were taken to ascertain irrigation water requirements for individual crops. The crops are in good condition and the experiments are in progress. Permeability tests on soils were carried out.

Rains have been particularly poor with 164 mm on the farm as against the minimum of 209 mm recorded at Vientiane during the same months in 12 years 1949/1960.

An evaluation of the results achieved during the previous seasons was submitted in the form of preliminary reports.

(b) Hydraulic works

The irrigation network in the first zone has now been completed by the construction of all canals and ancillary works. Construction of the canals in the second zone of the pilot area has commenced.

/ In the first

In the first zone, 10,761 meters of canals have been excavated and 27,274 cubic meters of earth was moved. 4 canal heads, 5 syphons, 146 locks, 6 bed drops, 6 turnout gates, 106 meters of lining on curves and 31 entrances to private properties were constructed. 5510 meters of roads were built. A motor pump was supplied by FAO for the first zone.

In the second zone, 3248 meters of canals were made involving excavation and 5,740 cubic meters of earth.

In order to improve technical facilities, a venturimeter was installed at the intake canal of the farm. Some alterations were made to the plot sizes of the experimental farm to allow for different irrigation solutions to be investigated.

(c) Demonstration and Extension

When the various canals of the first zone gradually came into operation, considerable interest was shown by the farmers in adopting new irrigated crops. A total of 54 farmers went in for irrigated crops, mainly vegetables, tobacco and fruit trees. It is worth mentioning that 4 farmers from outside the pilot area requested permission to use water from the canals of the project for irrigation and bore the cost of the necessary installations.

Seeds, fertilizers and pesticides were distributed to farmers. 446 kg of seeds to 29 farmers, 105 kg of fertilizers to 6 farmers and 59.7 kg of DDT to 46 farmers were distributed. 2183 bunches of rice seedling for an area of 3.50 hectares were also given.

(d) Training

Training of the 22 students at the school was somewhat thwarted by the lack of sufficient teaching personnel. Some substantial modifications were

/ made to

made to the syllabus as well as to the time-tales and subjects to suit the local needs.

(c) Government Participation

The Government participation in the project has been limited due to the political and economic situations. However, the Government has made available to the project a total credit of 20,026,820 Kips to overcome the financial problem of counterpart contribution.

c. Analysis of Major Problems

The sain problems experienced were as previously:

Shortage of technical personnel and local manpower due to ow wages (devaluation of the local currency), a very limited availability of heavy earth-moving machinery (in terms of number, time and efficiency);

a general lack of good quality needs for experimental and demostration work;

lack of Government funds during the first six months mainly due to the devaluation of the currency;

damage to crops by pests and diseases and lack of facilities for the treatment of seeds.

The Spedial Fund has granted an extension of this project by one year until November 1965. FAO has posted a Plant Protection Specialist to the project to deal with insects and pesticides. These measures should help to overcome the major problems to a great extent.

/ D. Evaluation

D. Evaluation

The programme of experimental crops is on schedule in spite of the lack of various facilities and manpower. Good progress was made in Hydraulic and irrigation works.

The progress of the Agricultural School suffered largely due to insufficient teachers. The demonstration and expension activities, although generally satisfactory, are behind schedule. Not withstanding one year's extension of the project, only restricted activity will be possible in the second zone.

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Committee for Coordination of Investigations
of the Lower Mekong Basin.

(Cambodia, Laos, Thailand and Vietnam)

DAMSITE RECONNAISSANCE

of the

LOWER MEKONG BASIN

by
Allen H. Nicol

DAMSITE RECONNAISSANCE

of the

LOWER MEKONG BASIN

Introduction

Four damsites on the main stem of the Mekong River and two sites on tributaries in northeast Thailand were visited in the field during the period of October 19 to 28, 1964. The main stem sites include the Upper and Lower Pakse, Khemarat and Thakhek; the tributary sites are the Nam Mune and Huey Bang Sai. A third tributary site, Nam San, could not be reached due to landslides on the road leading to the site. The writer was accompanied in the field by Mr. Lance Endersbee of the UNTAO, Mr. S. Ichiura of ECAFE, and engineers of the National Energy Authority, Government of Thailand.

During the period of this investigation the Mekong River and tributaries were in high flood stage. Observations were therefore severely restricted and limited entirely to the upper parts of the banks and abutments. Geophysical traverses were made along both banks of the Nam Mune site by Mr. Somchat Suathongcum of the National Energy Authority to determine overburden thickness. A photogeology study made by the writer prior to the field inspection supplied much useful data to supplement this report.

/ General

General Geology

The northeast part of the Khorat Plateau in which the sites are located is underlain by Triassic sedimentary rocks of the Khorat Series. They consist mainly of sandstone, siltstone, shale, mudstone, conglomerate and limestone. Five of the sites are in the Khorat Series but the Thakhek site, according to the published geologic map, is in Jurassic and younger sedimentary rocks consisting mainly of sandstone and shale.

The Khorat Plateau is a fairly stable land-mass which has been little affected by orogenic movement. Major faults, severe folding or other structural deformation is consequently not very common except along the margin of the plateau. Very gentle folding was found at the sites and in most cases the beds have a very low angle to nearly horizontal dip.

The sedimentary beds comprising the Khorat Series form a complex sequence ranging from durable, firm types of quartzose sandstones to soft, friable sandstones and weak shales. The various types show marked differences in their resistance to erosion and weathering and therefore they can be expected to have a wide range in their engineering characteristics. A brief description of these characteristics together with pertinent geologic features is given separately for each of the sites.

Nam Mune Damsite

This site is located approximately 600 meters downstream of a small island and rapids, and approximately 3000 meters from the confluence of the Nam Mune with the Mekong River. A tentative axis has been located, benchmarks have been set, and a topographic map and cross section compiled by the National Energy Authority. During the time of this inspection the high stage of the Nam Mune prevented observation of the lower parts of the abutments and therefore the data presented here are applicable only to the portion above water level.

Left Bank Geological Conditions

Brown river silt covers much of the left bank above water level (October 21, 1964) to approximately 101 meters, elevation, above which the slope steepens and is strewn with large sandstone talus blocks up to several meters in size. Sandstone bedrock crops out still further up slope and caps

/the flat

the flat upper part of the abutment. This rock is coarse-grained, part conglomeratic, with a northerly strike and a gentle to nearly horizontal westerly dip. Two sets of widely spaced joints were found, one set striking nearly parallel with the axis and the other perpendicular; these joints appear to be fairly tight at the surface. The sandstone beds range from less than a half meter to one meter or more in thickness and some show cross-bedding. The surface beds at the top of the slope are mainly massive, hard and firm but some interbeds are friable and weakly cemented. High seismic velocities were obtained by the geophysical investigation which indicate the presence of firm rock, with about 6 meters of overburden. It must be pointed out, however, that due to the limitations of the method and equipment used, the underlying interbeds (if present) of softer and weaker types such as clay shale, crumbly shale and sandstone or clay lenses cannot be detected due to their slower seismic velocities. The prominent slumping and downward creep of the large sandstone blocks along the abutment slope suggests that some firm beds have been undermined and detached by breakage along joints.

Occasional gray clay or shale beds were seen in the hill north of the village of Bon Pak but none were found in the general site area, nor along the axis of the dam. There is however, in my opinion, a strong possibility of clay or soft shale interbeds or intercalations within the foundation beds at the Nam Mune site. Some of these soft beds might have a thickness of one meter or more, but most would probably be less. Their possible occurrence at unexpected depths will require very careful drilling to avoid loss of core. Although practically impermeable, they will have doubtful stability for foundation support and may easily erode. Their position and thickness in the sequence of underlying foundation beds will need to be determined by borings.

Right Bank Geological Conditions

The right bank is covered by brown river silt with a high level terrace at approximately 100 meters elevation. A geophysical traverse along this terrace perpendicular to the axis indicates about seven meters of alluvial river silt and sand, which is comparable with overburden thickness found at the left bank. Average seismic velocities for the bedrock are much lower in the

/downstream

downstream direction from the axis than in an upstream direction. They are also lower than the velocities at the left bank. This suggests beds of weaker character underlie the downstream portion of the right bank. A distinct cliff line near the benchmark exposes fairly firm sandstone which compares favorably with the firm rock at the top of the left abutment.

Engineering Considerations

The favorable, although gentle upstream dip would tend to minimize the possibility of leakage along bedding planes. However, the east-west joints might be a source of leakage under the dam and might require grouting or other treatment.

There is no evidence in the field nor from the aerial phtotgraphs of old meanders of the Nam Mune or the nearby Mekong River, or of channel changes that might affect the damsite.

Slumping of large sandstone blocks along the left abutment suggests undermining by weaker beds. This situation, as previously pointed out, is one which calls for careful subsurface investigation.

The exposed bedrock in the upper part of both abutments is of sufficient strength to require blasting for effective excavation. Although some weakly cemented beds occur, the general conditions will call for rock excavation rather than earth excavation.

Overburden stripping of 6 to 7 meters, maily river silt and fine sand, is indicated. In the lower portions along the barks the overburden may reach 10 meters or more.

The engineering suitability of the firmer sandstone beds as crushed aggregate for concrete is difficult to evaluate visually and will require sampling and testing. Since sandstone is the prevailing rock of the area it should be possible by careful prospecting to locate a suitable quarry site.

Although the aerial photographs show sand and gravel bars in the Nam Mune and the Mekong Rivers, the high stage of both prevented their observation. Exploration in this regard is essential during low water.

In the event river diversion by tunnel method is adopted during construction, the left bank appears to offer a favorable alignment. The

/tunnel line

tunnel line will be nearly perpendicular to the strike of the gently dipping beds of dissimilar character, some of which will require support.

With a proposed H.L of 110 meters the impounded water will reach upstream as far as Ubol. The effect this may have upon the water table in the surrounding area beyond the reservoir limits is uncertain but some local raising can be expected where submerged beds of permeable rock reach the surface and can develop permanent ponding in the depressions.

Conslusions

The Nam Mune Damsite is underlain by sedimentary beds of the Korat Series consisting mainly of sandstones of dissimilar properties with a possibility of some thin clay, clay-shale or other weak interbeds.

The surface geological conditions appear to be fairly satisfactory for the construction of a concrete gravity dam at this site, but subsurface exploration by borings will be required to understand the foundation conditions in detail.

Some of the sandstone beds appear suitable for aggregate and riprap but others are friable and doubtfully suitable. Sand and gravel deposits for concrete aggregates could not be examined on account of high water but this should be undertaken during the low water period.

Since a concrete dam is envisaged at this site, the requirements for a side-channel spillway were not investigated.

Recommendations

In the event the Nam Mune Damsite is considered feasible from economic and other aspects, the following recommendations are presented as the first stage of a geological exploration program.

1. A detailed geological map should be prepared of the site area at approximately 1:2000 scale.

2. Geophysical investigations should be made during the low water period with traverses oriented perpendicular to the axis at different elevations to determine overburden thickness and bedrock conditions. This work can be done concurrently with the boring program, or after a few borings have been completed. It would also be helpful to make geophysical studies of

/the in-place

the in-place bedrock at the upper part of both abutments in order to better understand and correlate the seismic data with the borings.

3. Six borings are recommended in the initial stage. At each bank one vertical boring is recommended along the axis near crest elevation and one vertical boring midway downslope, making a total of four borings. Each of these vertical borings should be deep enough to provide a slight overlap in elevation between them to enable extrapolation equivalent to one continuous boring. The other two borings, one at each bank, should be inclined. They should be located near river level (to overlap slightly the bottom of the midpoint borings) and should be drilled deep enough and at such an angle that they will intersect each other under the channel of the river. In the event inclined borings are not possible, it will be necessary to erect a platform for drilling underwater in the main channel section of the river. All borings should be not less than size NX and should be pressure-tested. The utmost care should be used in order to obtain high core recovery.

4. The construction materials situation requires careful study. A survey should be made of sand and gravel bars in the vicinity of the site. In the event the volume is inadequate and the quality or gradation of the river aggregates is unsatisfactory for concrete it will be necessary to prospect for a quarry site to supply suitable crushed rock.

PAKSE DAMSITE AREA

Downstream Site Area

The area described here is located approximately midway between the confluence with the Nam Mune River and the boundary between Thailand and Laos, on the Mekong River, or approximately 3.2 kilometers upstream from the Laos boundary. The tentative site which was originally proposed to visit is located further downstream in Laos and was not inspected due to prevailing security regulations.

At the point where this description applies, the channel of the Mekong is quite narrow, being 250 meters or less, and is unquestionably very deep. Bedrock of the Khorat Series is well exposed along both banks. At the right

/bank

bank the bedrock is a medium-grained light yellow sandstone occurring in beds ranging from a half meter to two meters in thickness. The rock is quite firm, although some friable beds occur. Joints are narrow, tight and irregular in spacing; they trend more or less parallel to the axis, with minor joints perpendicular to the axis. The beds strike north and dip a few degrees west which gives them a slightly oblique but favorable upstream dip. There is no mud bank at the river line (October 21, 1964) and no evidence of terrace development.

At the left bank (Laos side) the beds appear somewhat thinner but of the same general character as those on the right bank, but no landing was made. Observation of the left bank was made by binoculars from the Thailand side of the river.

The foundation conditions for the construction of a concrete gravity dam should be good along this stretch of the Mekong, provided sandstone beds extend below water level. As previously pointed out, the Khorat Series consists mainly of sandstone but contains interbeds of soft, friable materials and clay. Although no evidence of soft interbeds was seen at the time of this visit, the possibility remains of their occurrence in the lower part of the sequence, and requires further study.

The aggregate situation will require detailed investigation. Due to high water no observation could be made of possible bars along the Mekong. The aerial photographs show very few bars in this area, however, but several occur some distance upstream in the visinity of the upstream site. The photographs also indicate an abundance of outcrops, probably sandstone, on both the Laos and Thailand sides of the river. On the Laos side a series of steep-sided, step-like benches occur, probably formed by differential erosion of soft and firm beds. By prospecting in this area it should not be difficult to locate a quarry site to produce crushed rock for coarse concrete aggregate but fine aggregate might be more of a problem.

There is a possibility that the channel of the Mekong here is too narrow to provide an overflow spillway of adequate size for the Mekong River at peak flood. However, the river widens both upstream and downstream so a

/more suitable

more suitable site could be tentatively selected. The geological conditions a short distance upstream or downstream should be generally similar to those which have been described.

Conclusions

The geological conditions in the upper part of the abutments appear favorable for the construction of a concrete gravity dam. Assuming rock of this character to extend down the abutment slopes (below presnet high water, October 21, 1964) and to underlie the channel, there would be no question about foundation stability. Some soft interbeds are likely to occur in the deeper foundation sections, however, and these can only be discovered by borings.

A tentative axis at this location is objectionable since the channel appears too narrow to provide adequate spillway capacity. Wider channel conditions prevail a short distance upstream and downstream from this location, however, where an axis of suitable width could be found, and where the geological conditions should be similar to those which have been described.

Gravel and sand for aggregates may not be locally available in the immediate vicinity but a quarry could be easily prospected and developed to produce crushed rock.

Recommendations

In the event this lower site is preferred to the upper Pakse site, a tentative axis location should be made where channel width and topographic conditions are favorable.

The lower Pakse site area should be revisited during the low water stage of the Mekong to observe the geological conditions and rock characteristics in the lower abutment slopes and the channel section, which could not be done during this trip.

Geologic mapping should be made in the site area prior to subsurface exploration in order to provide a basis for the preliminary boring program.

A construction materials survey should be made either concurrently with the geologic mapping or following it in order to evaluate the sand and

/gravel bars

gravel bars and potential quarry sites.

Upstream Site Area

The upstream Pakse damsite area described here is located approximately 6.5 kilometers upstream from the confluence of the Nam Mune River, or approximately 1.5 kilometers upstream from the confluence of the Huai Yang and the Mekong. Here the river flows in a narrow channel with bedrock exposed along both banks. The sedimentary beds belong to the Khorat Series and consist of nearly flat-lying sandstones and pebbly conglomerates. There is no apparent indication of folding, faulting or other structural deformation. The regional attitude, based on aerial photos, is a northerly strike and a very gentle westerly dip of a few degrees. The major joint system trends parallel with the stream flow, or northeast. Minor joints trend northwest, or approximately parallel with the axis. The joints are widely but irregularly spaced and fairly tight at the surface. Individual sandstone beds range from less than 1 meter to 2 meters or more in thickness.

Any number of tentative sites for a low dam could be located in this area where the geological conditions should be very nearly the same as those described but with greater channel width to provide adequate spillway capacity.

The foundation conditions should be very good in rock of this kind provided similar types occur lower in the sequence. Occasional beds are weakly cemented and friable, and the condition of the underlying beds in the channel area cannot be determined without borings. The Khorat Series contains a variety of soft interbeds which may be present in this area but could not be observed during high water. Based on the condition of the rock in the upper beds, blasting will be required for expeditious removal.

As construction material, some beds are probably unsatisfactory for aggregate or riprap on account of their friability. Other firmer beds might be entirely suitable for aggregate after crushing and processing. A quarry site to produce suitable crushed rock for coarse aggregate for concrete should be possible to locate through field exploration on either the Laos or the Thailand side. Evaluation of quality or durability, however, would require sampling and engineering testing. It would also be advisable to investigate the

/suitability of the

suitability of the finer crushed fractions for fine aggregate in the event an adequate supply of suitable river sand may not be readily available in the site area.

Conclusions

The geological conditions appear favorable for the construction of a concrete gravity dam in this area. This opinion is based on the assumption that the general character of the upper abutment rocks extend with depth and underlie the lower slopes and channel. A valid understanding of the rock conditions lower down in the sequence can only be obtained by subsurface investigation.

As is the case with the lower Pakse site, any number of tentative axes can be located within one or two kilometers upstream or downstream from the area which is described above, and where wider channel conditions prevail and the geological conditions should be similar.

A quarry could be easily located to produce crushed rock for construction purposes but availability of sand and gravel for aggregates will require investigation during low water.

Recommendations

In view of the similarities in geological conditions of the upper and lower Pakse site areas, the recommendations made for the lower site apply equally well to the upper Pakse site. Briefly, they include a revisit during low water, selection of a tentative axis, detailed geologic mapping and a construction materials survey.

KHEMARAT DAMSITE AREA

The Khemarat Damsite area is located approximately 25 kilometers downstream from Khemarat village, in the downstream part of a sharp bend of the Mekong River. The area described here is located on a rock spur in a narrow gorge, on the right bank (Thailand side.) It was visited on October 23, 1964 by boat during extreme high water. This location is approximately midway between the upper and lower tentative axes.

Triassic sedimentary beds of the Khorat Series are well exposed in the

/area. The

area. They consist mainly of medium to coarse-grained sandstones that strike northwest and dip northeast from 5 to 10 degrees. Individual beds range from less than one half meter to over one meter in thickness but most are less than one meter. Most of the sandstone beds appear fairly firm but occasional beds are weakly cemented and can be crumbled by hand. Surface beds in the upper part of the abutment may be more weathered than the underlying beds but high water prevented observation. Considerable slumping of these upper beds suggests undermining of weaker layers but no direct evidence was seen as to the character of the weaker interbeds. It is possible that lower in the sequence there may be soft shale or clay-shale interbeds or lenses but this possibility is not confirmed on account of high water. The major joints in this particular area are widely spaced, up to several meters apart, and trend northerly. Some are open and gaping at the surface, but they appear to close with depth. Potholing is extensively developed in some beds, and a black surface tarnish or glaze due to algae is common.

Location of a site in this area along the Mekong will be influenced by the prevailing northwest strike and northeast dip of the beds with respect to the course of the Mekong. Where the river flows parallel to the strike of the beds the axis of any dam will cross a series of beds having dissimilar engineering properties and there is a strong possibility that the bearing capacities of the foundation beds will vary greatly from bed to bed. This condition will create difficulties in the design of a concrete dam. There is furthermore the possibility of leakage along bedding planes. But in those reaches where the river flows more or less from north to south, the beds strike across the river, parallel with any tentative axis, and have a favorable upstream dip. This orientation is preferred in that fewer problems will be encountered in design and possible leakage will be minimized.

Faulting may occur near the downstream axis, on the right bank (Thailand side) in the vicinity of the falls, based on the air photographs. Two or three faults may occur there, and one of them may cross the Mekong below the falls. There was insufficient time to confirm their presence on the ground, but this can be done in the normal course of geologic mapping at a later date.

/Slickensides

Slickensides were found parallel to bedding planes in several places along the spur, but these may have formed by bedding plane glide during gentle regional folding. Otherwise no evidence of intense folding, severe fracturing or other structural disturbances were found. The left bank (Laos side) was not visited.

Based on the character of the upper beds, it is possible that some could supply aggregate or riprap. However, many beds appear too friable for aggregate. Prospecting of the area should be done to locate a suitable quarry site.

Foundation support should be adequate in the sandstone beds but the possibility of soft interbeds lower in the sequence and underlying the channel will require investigation by borings.

Conclusions

There is a possibility that sandstone beds of dissimilar properties with soft interbeds of an easily eroded or compressible type occur in the Khorat Series of the area.

A preferred axis location therefore is one which is parallel with the strike and the beds have an upstream dip.

This preferred orientation will be found in the nearby reaches of the Mekong which flow from north to south.

Feasibility of the site area for a concrete gravity dam will depend very largely on foundation conditions in the underlying strata which cannot at present be surmised, without subsurface investigation. Much additional information could be obtained, however, by revisiting the Khemarat Damsite Area during the low water period.

Recommendations

The Khemarat damsite area should be revisited during the low water period to observe the character of the underlying strata that should be exposed along the banks and in the channel. Two or more tentative axes could be arbitrarily selected at that time.

It is recommended that a tentative axis be located along the north-south stretches of the Mekong in order to provide a more favorable orientation of the strata for the dam foundation.

/after

After selection of a feasible axis location, detailed geologic mapping and a construction materials survey should be made. This work should precede any subsurface exploration in order to provide a basis for a preliminary boring program.

Since soft interbeds may be present in the underlying strata it is recommended that the utmost care be given during boring operations to assure high core recovery.

HUAY BANG SAI DAMSITE

This site is located approximately 23 kilometers northwest of Mukdahan in northeast Thailand on the Huay Bang Sai River, a tributary of the Mekong. It was visited on October 25, 1964.

The area is underlain by sedimentary beds of the Khorat Series consisting mainly of sandstone and some sandy shale, with occasional soft, weakly cemented interbeds. In the vicinity of the site a firm, fine-grained, gray sandstone is exposed along the left bank. These beds strike northwest and dip about 3° northeast. Firm beds cap the knobs of the low hills along the left bank and comprise most of the upper part of the left abutment. The right bank is covered by brown river silt and sand, with no outcrops. No evidence was found of faulting, folding or other structural disturbance.

Individual beds range from a few centimeters to about one-half meter in thickness. Two prominent sets of vertical joints occur. One set strikes northeast-southwest and the other set is perpendicular, striking northwest-southeast; less prominent oblique joints strike east-west. Jointing is widely spaced. The well developed jointing in the area is very likely responsible for the zigzag course of the stream. The channel here is not deeply incised by the young stream and is quite narrow.

Foundation conditions at this site should be satisfactory for a rock fill or a concrete dam, but this will have to be determined by field investigation and exploratory borings. It is very likely that some weaker interbeds may underlie the firmer sandstones but their thickness, bearing capacity and permeability need investigation. The prominent jointing conditions indicate

/some grouting

some grouting may be required if the joints extend very deep into the dam foundation. The axis of the dam has an approximate azimuth of north 30° east and will therefore cut obliquely across the dip of the foundation beds at a very small angle. Since the beds have a gentle downstream dip, it is possible that if permeable sandstones occur in the lower part of the foundation beds they will require adequate cut-off and grouting to minimize leakage.

Sand and gravel bars are not prominently developed along the stream; the availability of streambed aggregates for concrete is therefore questionable and requires investigation. Rock is abundant, however, and quarries could be developed without much field study. Embankment materials should be plentiful along both banks and impervious core material can probably be found along the left bank near the site.

A contact between members of the Khorat Series probably occurs less than one kilometer northeast of the site. There the soil conditions have a lighter tone, the drainage pattern is different and the terrain is more flat with few knobs and hills. This change in conditions and terrain may mark the contact between the upper (Phu Pan) and the middle (Phra Wihan) members of the Khorat Series (or possibly between the middle and the lower (Phu Kadung) members. According to published reports the contacts within the Khorat Series are conformable, hence there should be little if any difference in the dip of the beds in each member. Considerable differences can be expected in the character of the sedimentary beds, however, but since this contact occurs a reasonable distance from the site it should have little if any affect upon foundation conditions there.

There may be beneficial effects upon reservoir conditions on account of this contact location in that the area north of the site and for some diatance west (upstream) is probably underlain by fine-grained, impervious materials. This favorable condition appears to extend upstream for at least ten kilometers.

Conclusions

From a geological standpoint this site appears feasible for the construction of a concrete dam, but this opinion will have to be established by field investigation and exploratory borings.

/Sand and Gravel

Sand and gravel aggregates for concrete may not be available for concrete construction in the vicinity of the site but rock is abundant, however, and a quarry could be developed for crushed rock.

No unusual problems or difficulties are envisioned which would affect design and construction. Exploration here can be conducted by a minimum number of borings, test pits or trenches.

Recommendations

A geologic map and a construction materials survey should be made for the site area.

A minimum of three borings should be made as a preliminary subsurface exploration program. One of these should be a vertical boring near the midpoint of the channel to determine overburden thickness and character of bedrock. The other two, one along the river line at each bank, should be inclined to intersect each other under the channel. These borings should be no smaller than NX diameter and water pressure tests should be made.

Two test pits should be made on each abutment slope to determine overburden thickness, followed by geophysical studies.

THAKHEK DAMSITE AREA

The Thakhek site is located approximately 15 kilometers northwest (upstream) of Nakhon Phanom on the Mekong River in northeast Thailand.

This area is characterized by flat lands bordering the banks and the river is quite wide. The banks are covered by brown river silt and sand and no exposures of rock were seen during the visit.

A long flat strip of land is under extensive cultivation on the Thailand side which extends over 3 kilometers upstream from the tentative dam axis. No outcrops were seen during the period of the visit.

The left bank (Laos side) was not visited but the air photographs show a series of low ridges and depressions trending parallel with the Mekong about one kilometer from the shore. This condition may be caused by tilting of the beds near the margin of the plateau but this opinion is conjectural and unconfirmed. To what extent the underlying sedimentary beds in the channel and on the Thailand

/side may

side may be similarly tilted cannot be surmised. The air photos do not show evidence of any kind. It therefore remains to visit this area during a low period of the Mekong to observe bank and channel conditions.

Based on published geologic data, the Thakhek area is underlain by Jurassic and younger sedimentary and metamorphic rocks, mainly sandstone and sandy shale. In this respect, the Thakhek site is different in being the only one investigated that is not underlain by the older Triassic beds of the Khorat Series. The Mekong flows through this belt of Jurassic rocks from as far north as Nong Khai and the gradient of the river is quite low between Bung Kan and Thakhek. To what extent these conditions may reflect the character of the underlying bedrock at the Thakhek damsite is not easily surmised, and can only be known by subsurface investigation. It is possible that the bedrock conditions here may be less satisfactory for foundation support than is the case in the Khorat beds at the other sites.

Conclusions

Geological conditions at the Thakhek site are uncertain due to a lack of bedrock exposures.

This situation will probably call for a greater amount of subsurface investigation than at the other sites.

It seems probable that the entire site area is underlain by a much softer grade of bedrock than is the case at the other sites.

The topographic conditions at the tentative axis location do not appear to be very satisfactory due to the wide channel and low, flat areas bordering both banks. Alternate axis locations do not appear possible upstream or downstream.

Recommendations

A second reconnaissance of the Thakhek area should be made during low water to observe bank and channel conditions and to select a favorable axis location, followed by geologic mapping and a construction materials survey.

/SUMMARY

SUMMARY

1. All of the sites investigated except Thakhek appear reasonably feasible for dam construction.

2. The Thakhek site may require a greater amount of exploration than the others in view of topographic features and uncertain geologic conditions.

3. Several tentative axes can be selected along the Mekong in the vicinity of the Upper and Lower Pakse and Khemarat sites where the geological conditions are considered to be similar to those described in this report.

4. An axis location in any given case can best be determined by a careful study of channel width to provide adequate spillway capacity, by consideration of bank and channel conditions during low water, and the topographic features which will affect river diversion and dam construction.

5. The critical location of the proposed Nam Mune Damsite near the confluence with the Mekong with respect to either the Upper or Lower Pakse sites presents a serious problem to the construction of any dam on the Mekong in the vicinity.

6. The very great size of any dam to be built on the Mekong coupled with extremely difficult channel diversion problems, unfavorable conditions for a side-channel spillway and navigation and other requirements would seem to favor the construction of a concrete gravity dam.

7. Geological conditions in general appear to be reasonably favorable for concrete gravity dam construction but much exploration will be necessary to clearly understand the foundation problems.

8. The construction of concrete dams of this magnitude involves a very great volume of coarse and fine aggregate. Sandstone is the predominant bedrock of the region but many beds are soft and weathered. Although some hard, firm beds are known to occur, their location, quality and volume available will require considerable prospecting in the vicinity of any given site. In some cases sand and gravel bars may supply fine and coarse aggregates but this possibility also bears careful investigation in the vicinity of each site.

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ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST.

Committee for Coordination of Investigations
of the Lower Mekong Basin.

(Cambodia, Laos, Thailand and Viet-Nam)

REPORT ON THE TRIP TO MEKONG RIVER MAIN-STEM AND TRIBUTARY PROJECTS

by

S. Ichiura

Report on the Trip to Mekong River Main Stem
and tributary projects

by

S. Ichiura

1. The purpose of this trip is to make field inspection of four main stem damsites namely upper Pakse, lower Pakse, Khemarat and Thakhek, and three tributary projects namely the Mune, Huey Ban Sai and Nam San from engineering and geological [1]/ point of view. The last project Nam San, however, was inaccessible, because of bad road from Loei.

Land and river transportations were provided by National Energy Authority, Government of Thailand from Ubol to Khon Kaen about 1,400 km in total. An aluminum boat contributed by the United States was used to travel the river.

2. Itinerary

Sun.	18.10.64	1st day	Lv. Bangkok 19.30 by train
Mon.	19.10.64	2nd day	Arr: Ubol make arrangement for boat
Tues	20.10.64	3rd day	Lv. Ubol for Ban Dan Arr. 19.30
Wed.	21.10.64	4th day	Visit the Mune river damsite and lower and upper Pakse damsite. Stay Ban Dan overnight.
Thur.	22.10.64	5th day	Lv. Ban Dan Arr. Khemarat
Fri.	23.10.64	6th day	Inspect Khemarat damsites Arr. Mukdahan
Sat.	24.10.64	7th day	Visit Mukdahan gauging station on NEA office stay overnight
Sun.	25.10.64	8th day	Lv. Mukdahan Visit Huey Bang Sai damsite and Thakhek damsite Arr. Sakorn Nakhon stay overnight
Mon.	26.10.64	9th day	Lv. Sakorn Nakhon Visit Nam Pung Dam under construction Arr. Khon Kaen
Tues.	27.10.64	10th day	Visit Nam Pong project under construction stay Khon Kaen overnight

1/ Geological report is submitted by Mr. Allen H. Nicol (c.f. WRD/MKG/INF/L.139. 19 November 1964) who joined our trip.

Wed.	28.10.64	11th day	Lv. Khon Kaen Arr. Loei, inspect the road to Nam San site stay overnight
Thur.	29.10.64	12th day	Lv. Loei Arr. Bangkok 23.00 by car.

3. Field investigation report

1. Nam Mune project (c.f. Fig. 1)

Nam Mune project is located on the Nam Mune river, 6 kilometers upstream from the confluence with main stream. This is a multiple-purpose project for power, navigation and irrigation. High water level of this project is 110 m above seal level and height of the dam will be about 30 m from the river bed. Length of crest of the dam will be at least 350 m by the map surveyed by NEA engineers. Both banks expose rock outcrops of sandstone upwards from the place several metres high from the river banks. Depth of bed rock foundation is not known at present stage but this site indicates that concrete gravity dam would be designed and constructed without much difficulties if the river bed is not so deep. NEA made geophysical investigations at the site on both banks of the river. This test shows that over-burden is deep about 7 meters at 110 m level.

The basic problem is the relation between this project and Pakse dam. Present location of Pakse dam site is proposed below the confluence of the Mune and main stem of the Mekong with the reservoir level of 108 m above sea level. As the high water level of the Mune project is 110 m as stated before, only 2 metre difference would be existing between two reservoirs. It means that these two projects can not be consistent with each other. If the Mune River project has to be built, the Pakse dam should be moved upstream from the confluence. But from pure engineering stand point it is much more economical to build one dam on the main stem at the downstream side of the confluence. Anyway, some coordination should be made between Thai Government and Mekong Committee to stabilize the basic consideration of these two projects.

2. Pakse dam site (c.f. Fig. 1)

We visited Pakse dam site both downstream and upstream sites. Original location is the former one and there are a few sites about 4 kilometres downstream from the confluence where the river width are only 250-300 m.

(c.f. Fig.1) with good sandstone abutments on both banks. However required length of spillway to evacuate maximum flood flow would be at least 600 m, so these sites are too narrow for it.[1/] However it is not difficult to find wider section near this area to build about 25 m high dam with favourable foundation rock near Laos-Thailand border.

Pakse upstream site is almost the same situation with the downstream ones. Islands and shoals in the map were all submerged by flood water when we visited the site. However some good damsites would be available also in this area. Upper Pakse No. 2 dam site looks good having favourable conditions, if foundation rock is suitable.

3. Khemarat dam site (c.f. Fig.2)

Khamarat was the most difficult site to access. Boat trip from the town of Khemarat to the proposed dam site was inadequate because of dangerous rapids between these two locations. We had to drive our Landrover to the small village Wat Si Chan and carry aluminum boat by jeep to inspect the damsite from downstream side.

Almost all island shoals and rapids indicated in the maps were disappeared because of flood flow. We went upstream by boat from Wat Si Chan to the mouth of small tributary Se Bang Nouau and found favaourable site for the dam (No. 3) at the corner of big bend of the Mekong river.

1/ Maximum design flood for Pakse would be at least 50,000 m^3/s and if we assume the depth of spillway gate at 15 m., 1. width of this gate can spill about

$$Q = CBH^{\frac{3}{2}} = 2.0 \times 15^{\frac{3}{2}}$$

$$= 2.0 \times 58 = 116\ m^3/s$$

Width required for 50,000 m^3/s

$$50{,}000 : 116 = 430$$

including spillway piers, lock and other facilities width of the main stream dam would be 550-600 m order.

It must be noted that this calculation does not take the effect of river stage of flood flow into account.

From No. 1 to No. 3 all damsites look no big difference among them. No. 1 site has narrowest width but some foundation problems may occur because the rock bedding is parallel to the river channel dipping to the right bank. This formation might cause deep foundation on the right bank and leakage through sandstone strata. No. 2 site has wider width and lower bank elevation than No. 1 site which may result larger volume of concrete for the dam but dipping and strike of the foundation rock is more favourable than No. 1. No. 3 site is just at the corner of the big bend which may cause difficulty in designing spillway, lock and power house through foundation rock looks fine. It is necessary to make further investigation in dry season for this area in order to make final dicision of the dam site. Landing area just downstream of No. 1 damsite shows most favourable rock foundation. It would be also a good site if length of dam is enough for it.

4. Mukdahan Gauging station

We visited Mukdahan gauging station on 24 October 1964. This is one of the most important stations on the main stem and seems well maintained and properly taken care of by NEA. Staff gauge reading was 6.31 m. at that time and the river flow will be 11,400 m^3/s according to the stage flow curve.

5. Huey Bang Sai dam site (c.f. Fig.3)

This site is on the small tributary of the Mekong near Mukdahan and about 7 kilometres from Ban Kham Plan Lai along Highway 33.

Cars are not accessible except about one kilometres from the highway. We could inspect the site of the dam only from the left bank where higher portion exposes good sandstone. Near the river bank mostly covered with silt, the width of the river was about 10 metres and deepest portion about 5 metres according to the information of a fisherman living nearby. We estimated the flow at 30 m^3/s by eye measurement.

The proposed dam is about 30 m high and it would not be difficult to build such comparatively low dam due to the outcrop of sandstone on the left bank. More detailed survey and investigation would be required to proceed this project and access road should be built to do so.

6. Thakhek dam site (c.f. Fig 4)

Because of the Joop trouble which transports the boat, we could not inspect

the Thakhek damsite by boat so we did only from the right bank by car. The site is about 11 kilometres from Thakhek. This area is low on both banks, it is very clear by 1:20,000 scale map and main highway is running along the right bank, and paddy field and farmers' houses are located in large scale on this bank. Difference of level between right bank and the river was 7 metres by simple hand level measurement at the proposed dam site. If we build a dam at this section raising water level up to 145 m most of the farmland and houses near banks would be flooded. However site for Thakhek is very much restricted because of the topography and to my judgement it will be very difficult to find other alternative site in this area. River is comparatively flat slope here and overburden looks likely thick, therefore, more detailed topographical and geologic investigation should be carried out before final decision would be made.

7. Nam San damsite.

Nam San project is situated on the Nam San river, a small tributary of the Mekong near Loei. The proposed damsite is about 70 kilometre from Loei, however, we were not able to access the site, because the road leading to Nam San river was land-slided.

8. Conclusions and recommendations

Main stem projects - The time we have visited these sites, was just after the rainy season, therefore, water levels of the rivers were extremely high, in other w rds, were in flood stage. In this connection, it was rather easy to travel the river because some rapids, shoals and islands which would make difficult to pass in dry season were disappeared under water. On the other hand, however, it was very difficult to inspect river bank and foundation conditions which would be exposed in dry season, as a result every dam sites look very similar each other and were difficult to identify the best one. Though we had some difficulties, we could inspect river flow conditions in flood season, general topography and general geologic pictures. However, it is strongly recommended that field inspection trip in dry season should be made in order to make final decision of the main stream dam sites and at the same time to make close coordination with National Energy Authority to solve the basic Mune-Pakse problem.

As for other tributaries further detailed investigation should be madefor the evaluation of the projects.

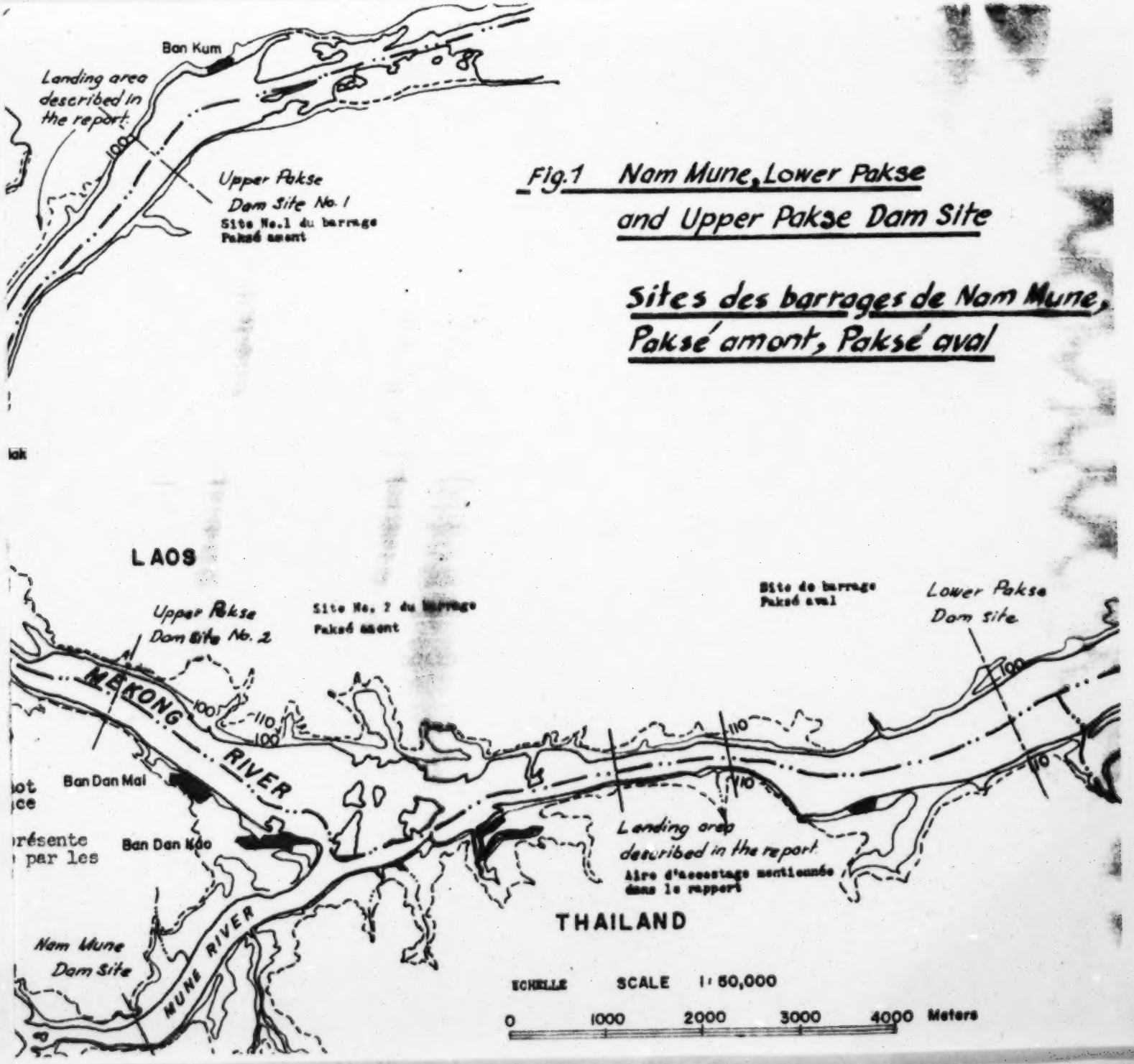
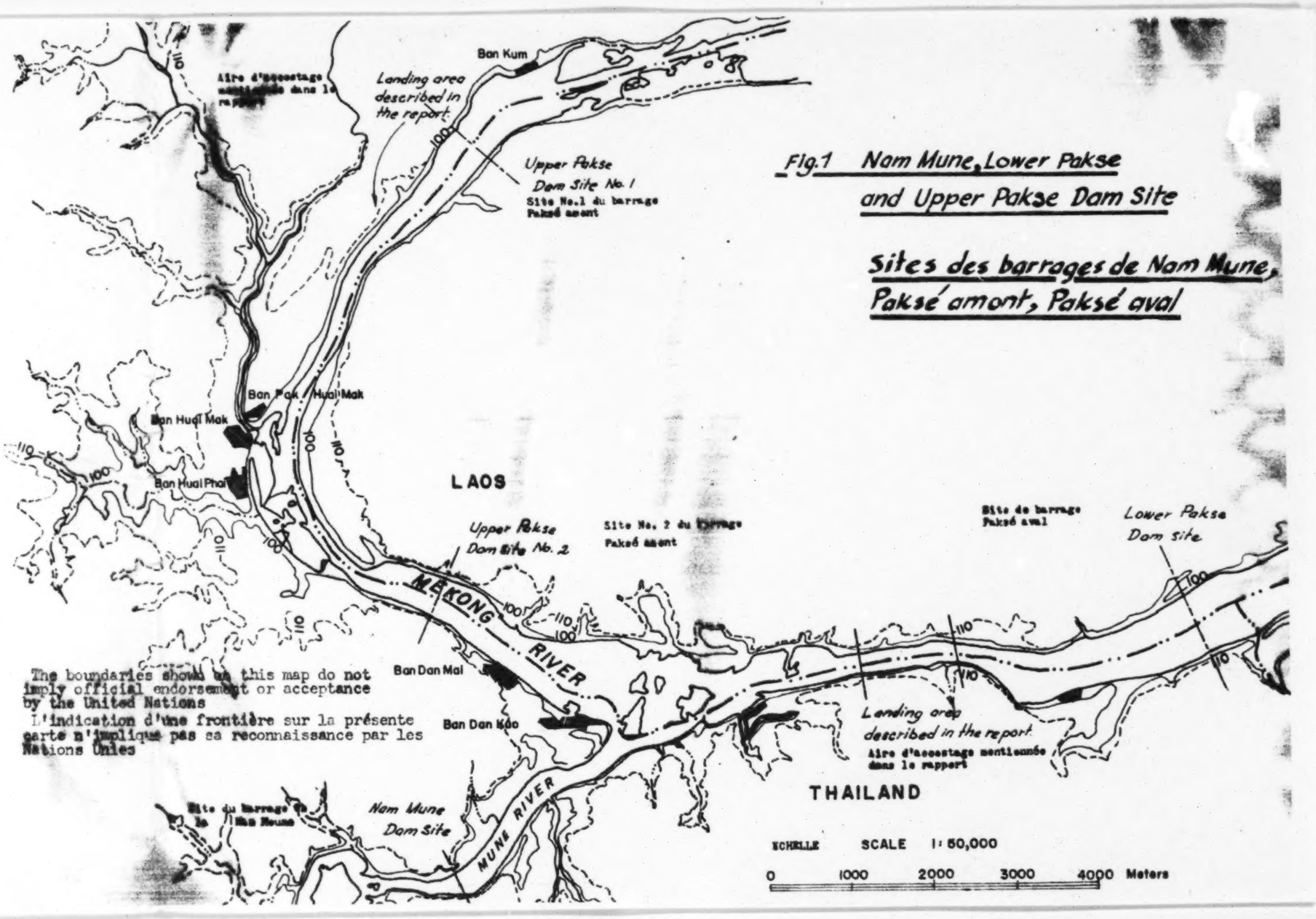

Ban Kum
Landing area described in the report
Upper Pakse Dam Site No. 1
Site No.1 du barrage Paksé amont
LAOS
Upper Pakse Dam Site No. 2
Site No. 2 du barrage Paksé amont
Site de barrage Paksé aval
Lower Pakse Dam site
MEKONG RIVER
Ban Dan Mai
Ban Dan Kao
Landing area described in the report
Aire d'accostage mentionnée dans le rapport
THAILAND
Nam Mune Dam Site
MUNE RIVER
ECHELLE SCALE 1: 50,000
0 1000 2000 3000 4000 Meters

Fig.1 Nam Mune, Lower Pakse and Upper Pakse Dam Site

Sites des barrages de Nam Mune, Paksé amont, Paksé aval


Ban Kum
Landing area described in the report
Upper Pakse Dam Site No. 1
Site No.1 du barrage Paksé amont
Ban Pak Huai Mak
Ban Huai Mak
Ban Huai Phai
LAOS
Upper Pakse Dam Site No. 2
Site No. 2 du barrage Paksé amont
Site de barrage Paksé aval
Lower Pakse Dam site
MEKONG RIVER
Ban Dan Mai
Ban Dan Kéo
Landing area described in the report
Aire d'accostage mentionnée dans le rapport
THAILAND
Nam Mune Dam Site
MUNE RIVER
The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations
L'indication d'une frontière sur la présente carte n'implique pas sa reconnaissance par les Nations Unies
ECHELLE SCALE 1: 50,000
0 1000 2000 3000 4000 Meters

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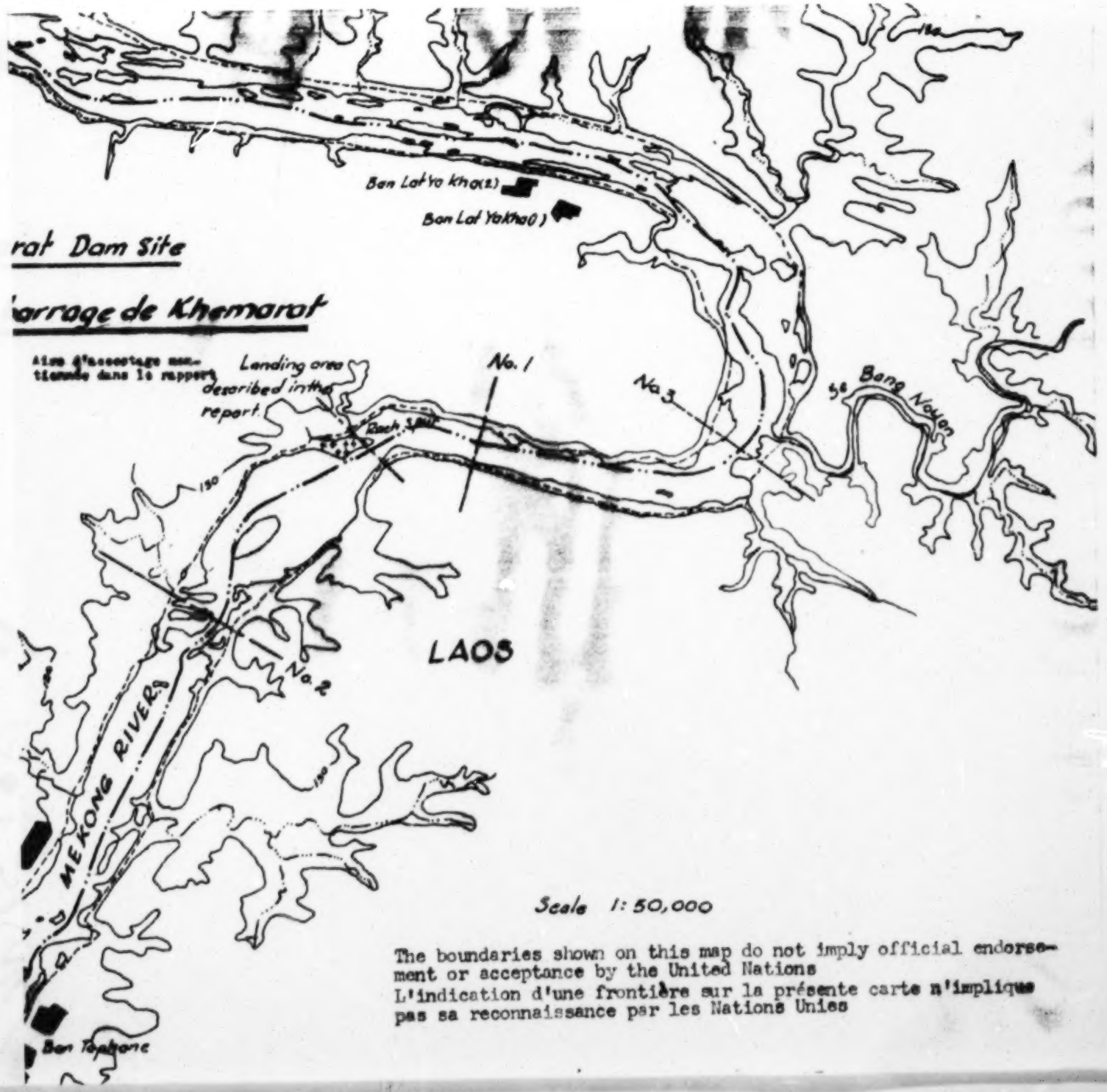
Sites des barrages de Nam Mune, Paksé amont, Paksé aval


Ban Lat Ya kha(2)
Ban Lat Yakha(1)
rat Dam Site
'arrage de Khemarat
Aire d'accostage mentionnée dans le rapport
Landing area described in the report
No. 1
No. 3
Ban Nayon
LAOS
No. 2
MEKONG RIVER
Ban Tapheng
Scale 1:50,000
The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations
L'indication d'une frontière sur la présente carte n'implique pas sa reconnaissance par les Nations Unies

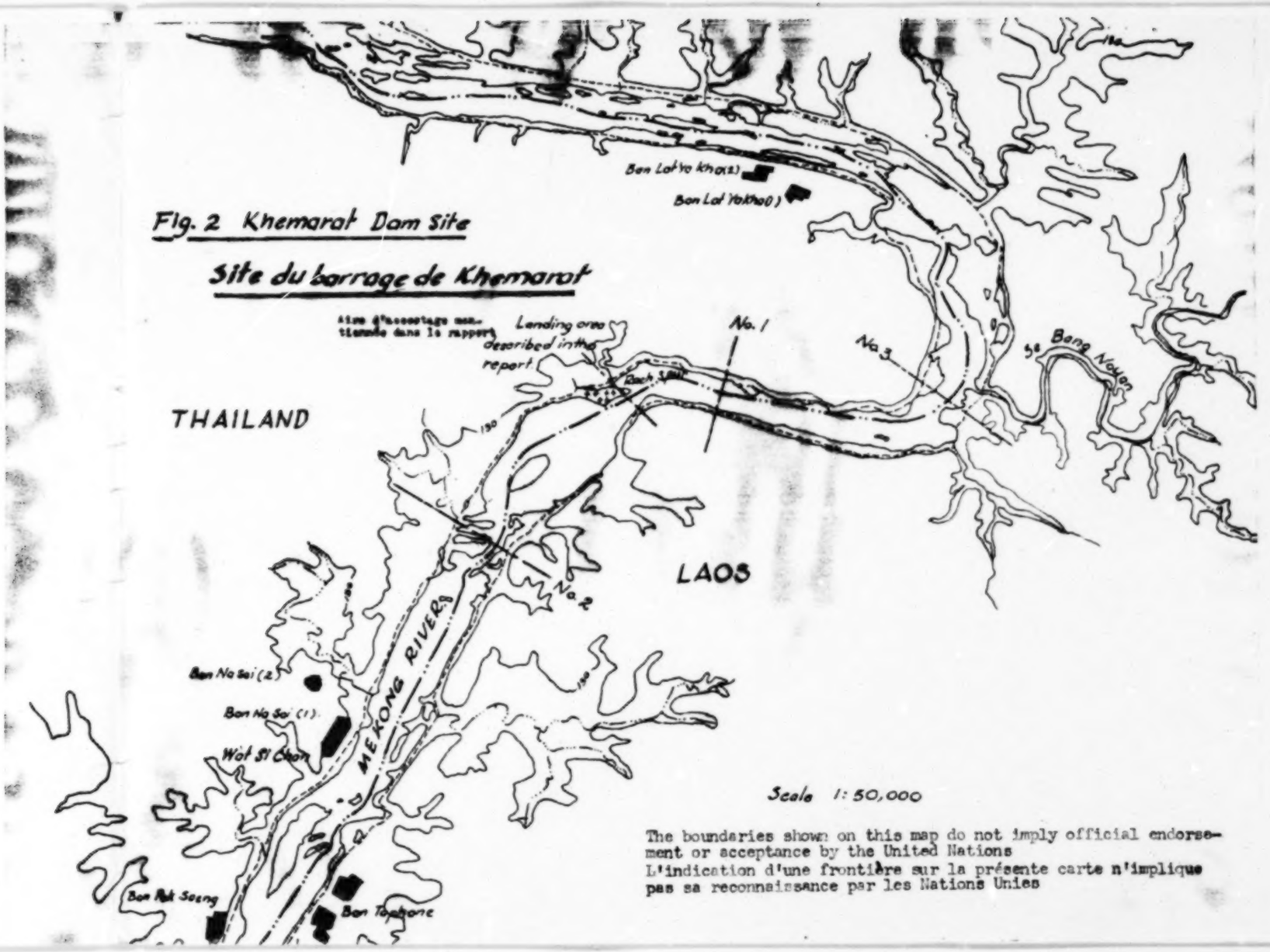


Fig. 2 Khemarat Dam Site

Site du barrage de Khemarat

Scale 1:50,000

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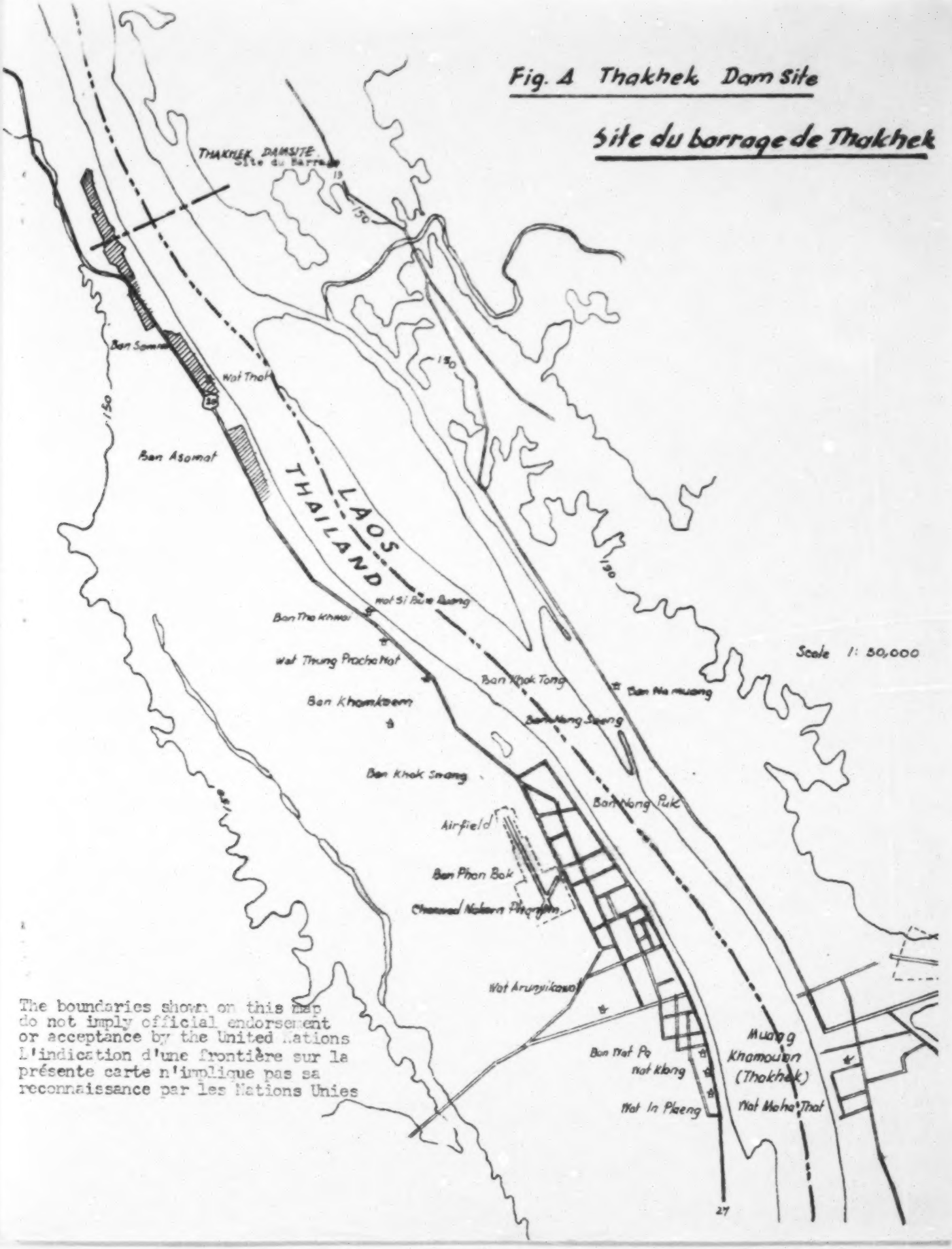
Fig. 3 Huai Bangsai
Dam Site
Scale 1: 50,000
Ban Kham Pla Lai
Site du barrage
de Houl Bang Sai
Huai Bang Sai Dam Site
HUAI BANG SAI
Mukdahan.
180
200
190
160
170

Fig. 4 Thakhek Dam Site

Site du barrage de Thakhek



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